

USNA Satellite Lab/Ground Station

Bob Bruninga, Ground Station
Engineer

- Satellite and communications Labs
- Satellite Design Projects
- Ground Station Operations
- Extracurricular

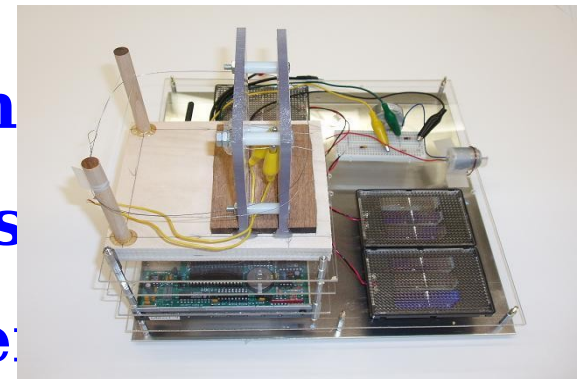
April 2006



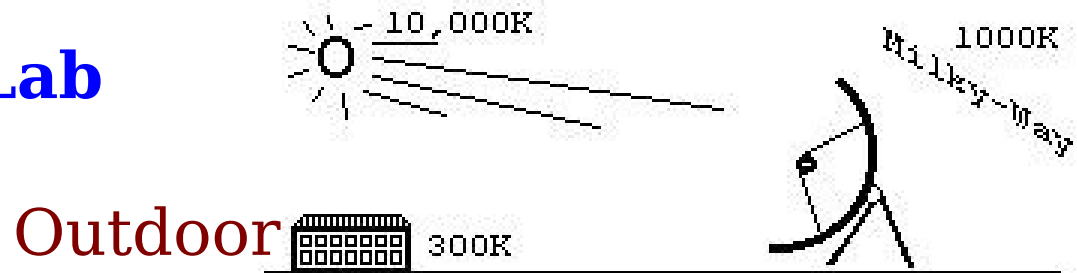
RAFT & MARScom

Satellite Labs

- Communications, Links, Antennas
- Communications, Receivers
- EPS, Electrical Power Systems
- Signals and Telemetry
- Thermal Lab



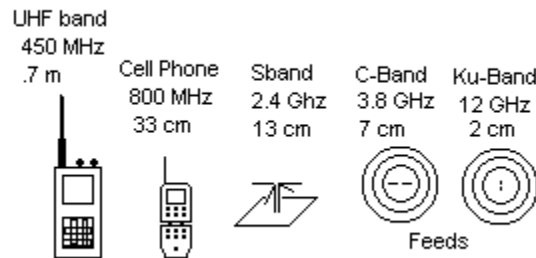
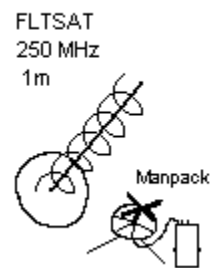
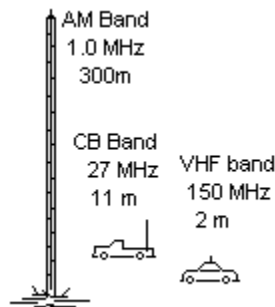
Indoor



Outdoor

Noise temperature

Communications, Links, Antennas



Wavelength

Antenna Size

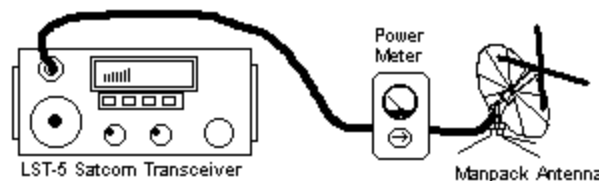
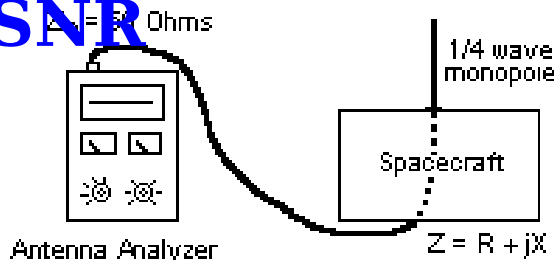
Types

UFO

**Gain,
Beamwidth**

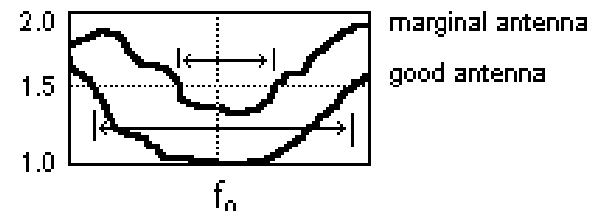
Link Budget

SNR



267.05 MHz

UFO or FleetSat



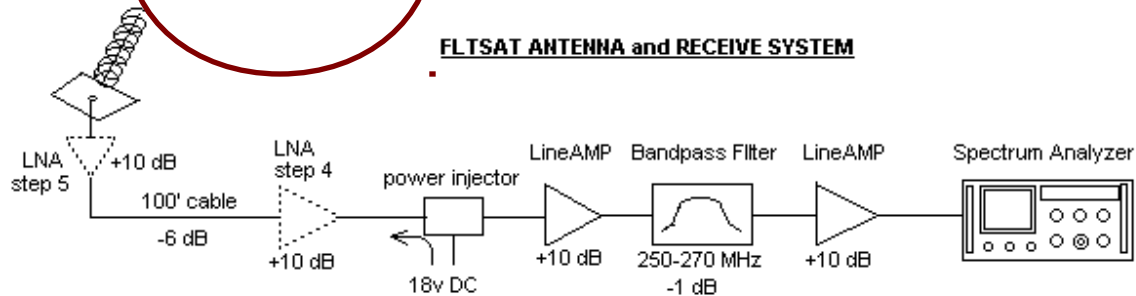
SWR

Matching

Communications, Receivers, Losses

UFO

FLTSAT ANTENNA and RECEIVE SYSTEM



Gain, losses

Amps and
LNA's

Cable losses

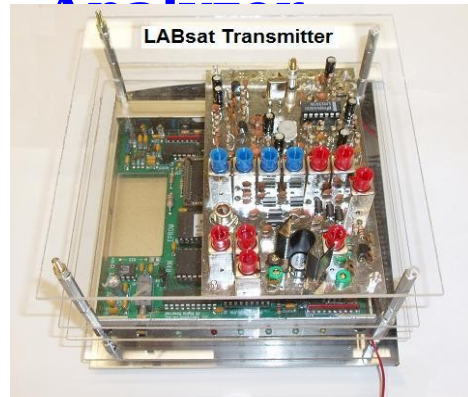
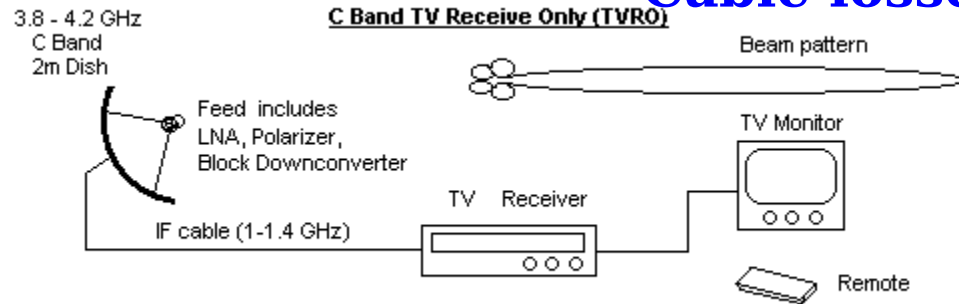
Geo-Arc

Beamwidth

Spectrum

Analysis

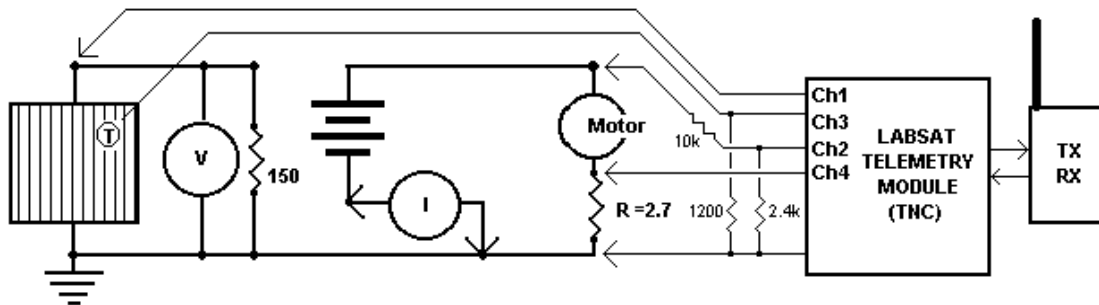
C Band TV Receive Only (TVRO)



Downconverte
rs

Demod,
Decoding

EPS Lab



EPS
LABsat
Design Lab

**Solar
Panels**

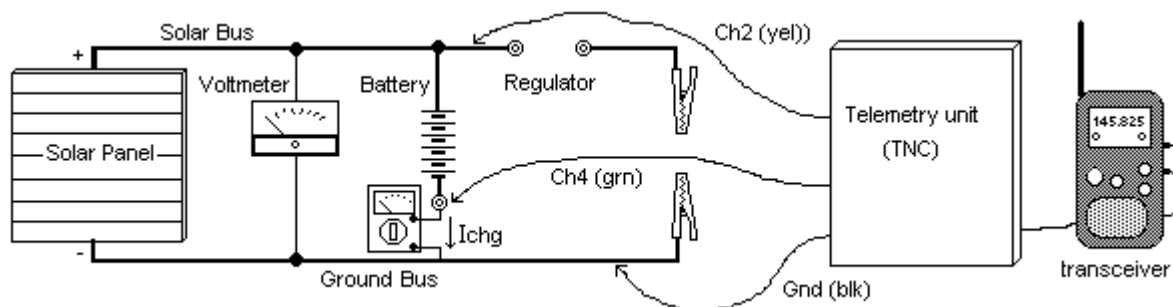
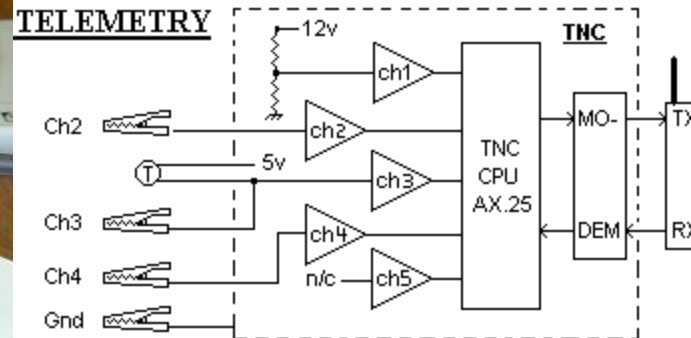
I-V curves

**Distributio
n**

Regulation

Shadowing

RTG demo



Sensors

Circuits

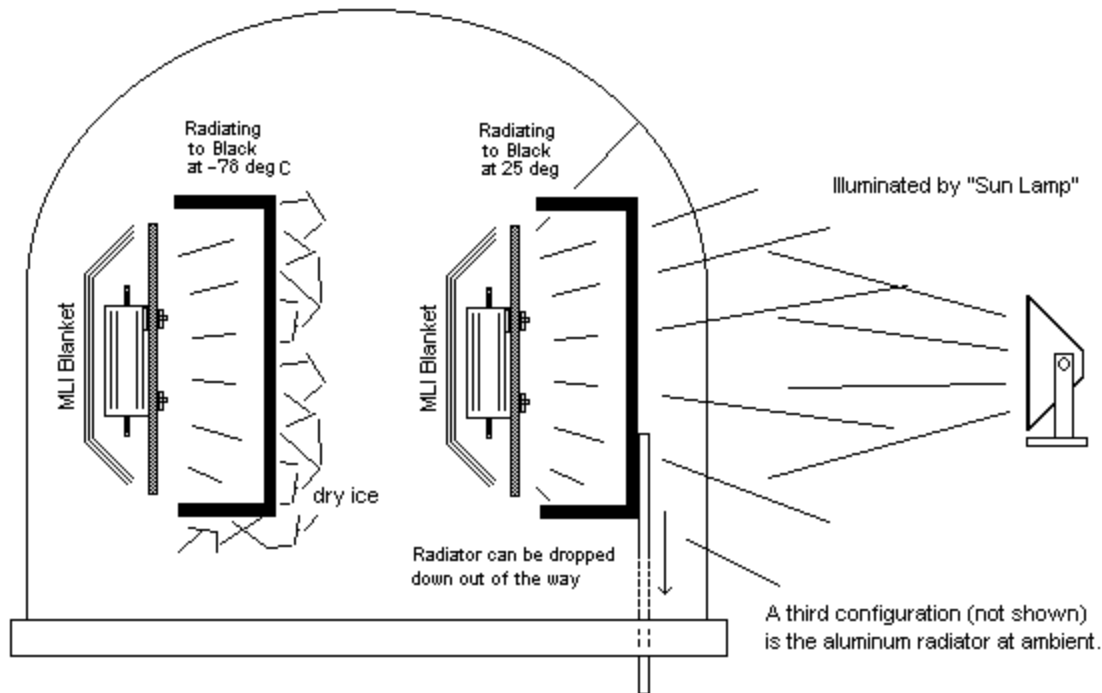
Conditioni ng

Engineeri ng conversio n

Decoding

Protocols

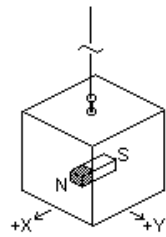
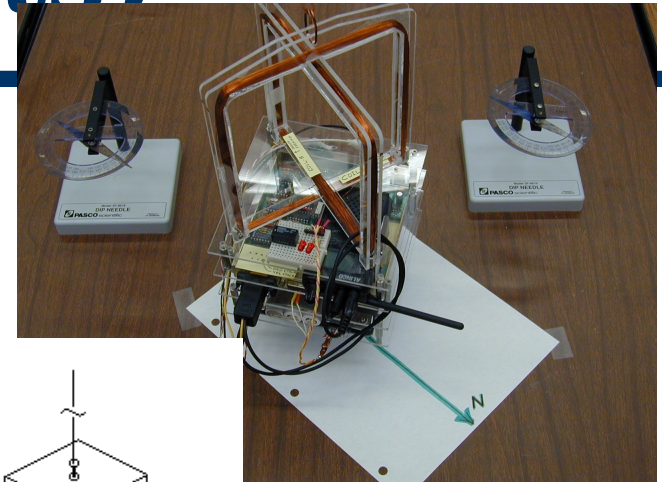
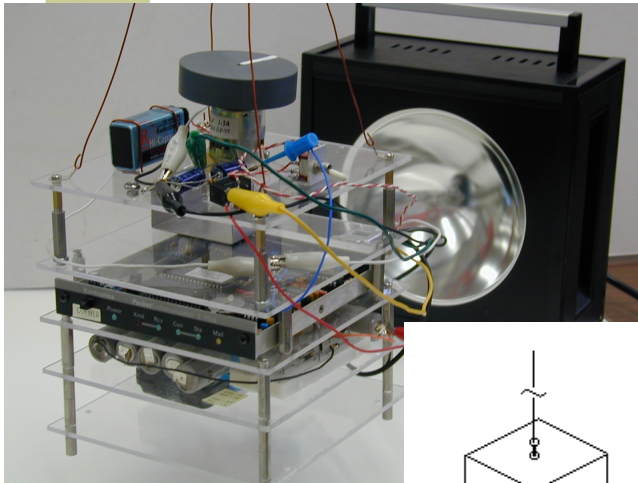
Thermal Lab



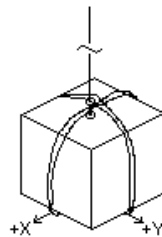
Hope to make this LABsat-based this
Fall

Conduction
Radiation
Absorptivity
Emissivity
Insulation

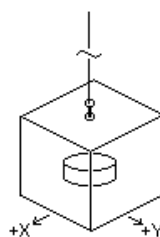
Attitude Control Labs (LABsats)



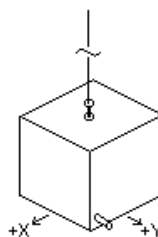
MAGsat



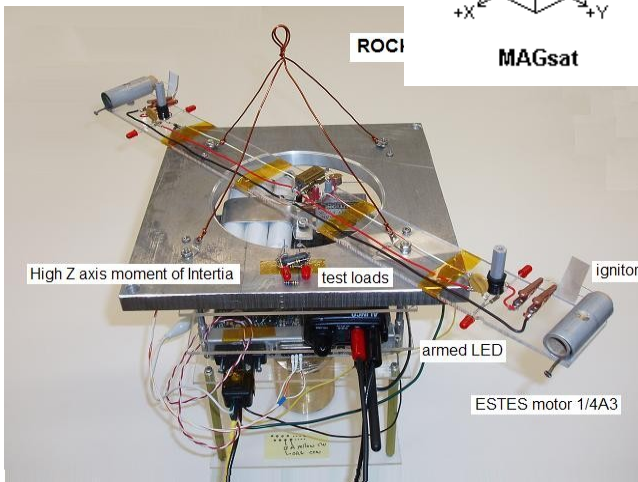
TORQUEsat



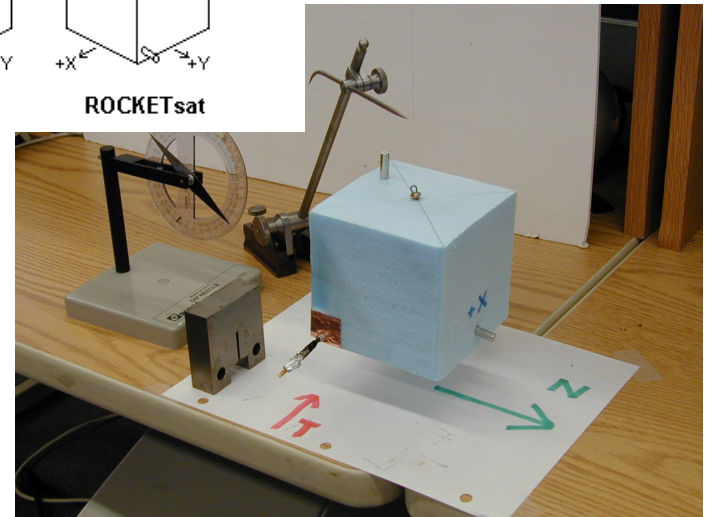
SPINsat



ROCKETsat



Can
demo all
but
gravity
gradient



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- Satellite Design Projects
- Ground Station Ops
- Papers & Presentations
- Extracurricular



**USNA
SATELLITES**

Satellite Design Projects

➤ **NATSw***web***** – 1st Sea-Launch (scrubbed in last week!)

➤ **PCsat** – **Launched** 30 Sept 2001

➤ **Sapphire** -- **Launched** 30 Sept 2001

➤ **PCSAT2** – **Launched** 26 Jul 06 return to flight

➤ **ARISS** – **Launched** on Progress Aug 2003

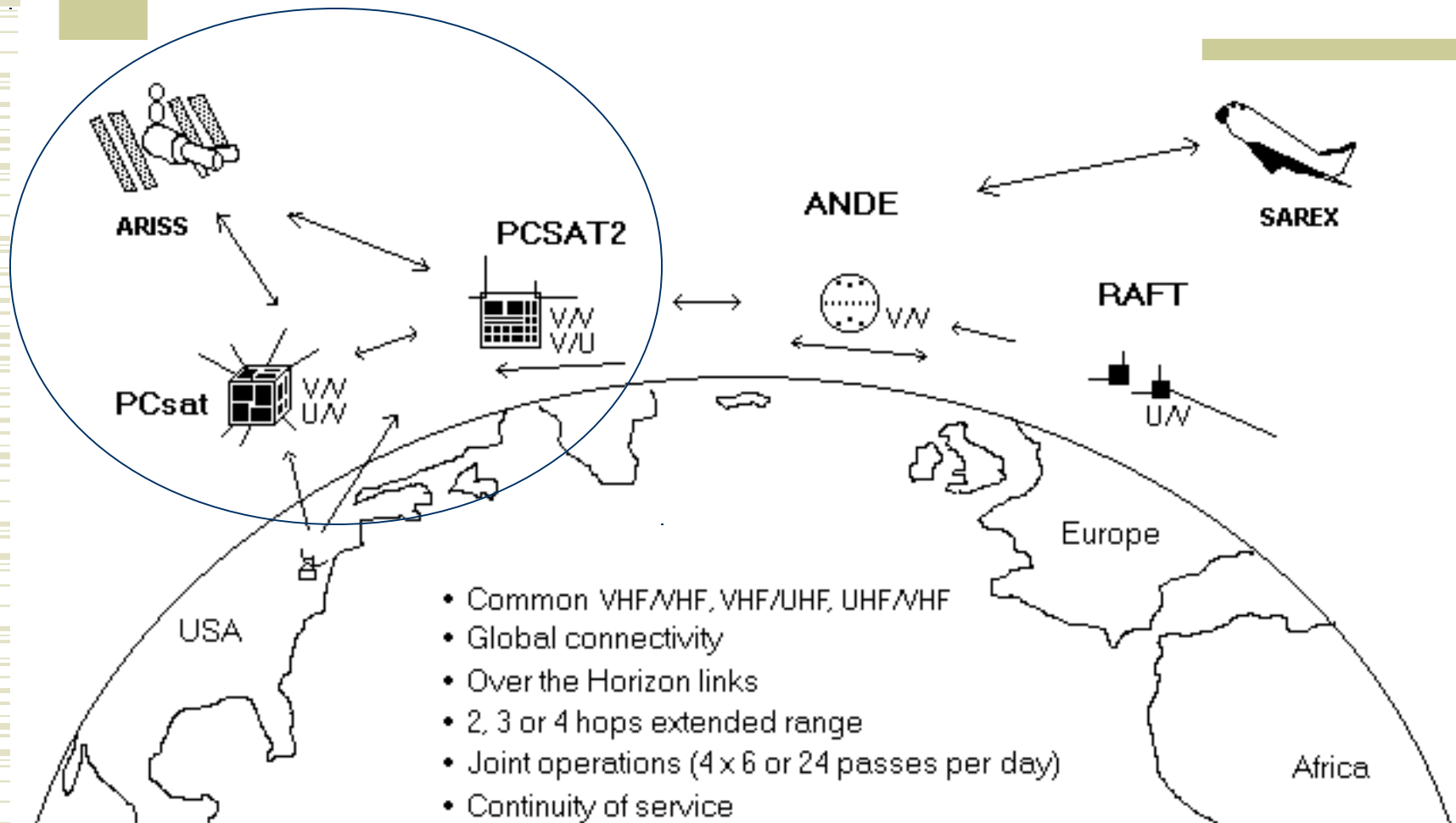
➤ **ANDE** – **Manifest. STS-116**

➤ **RAFT1** – **Manifest. STS-116**

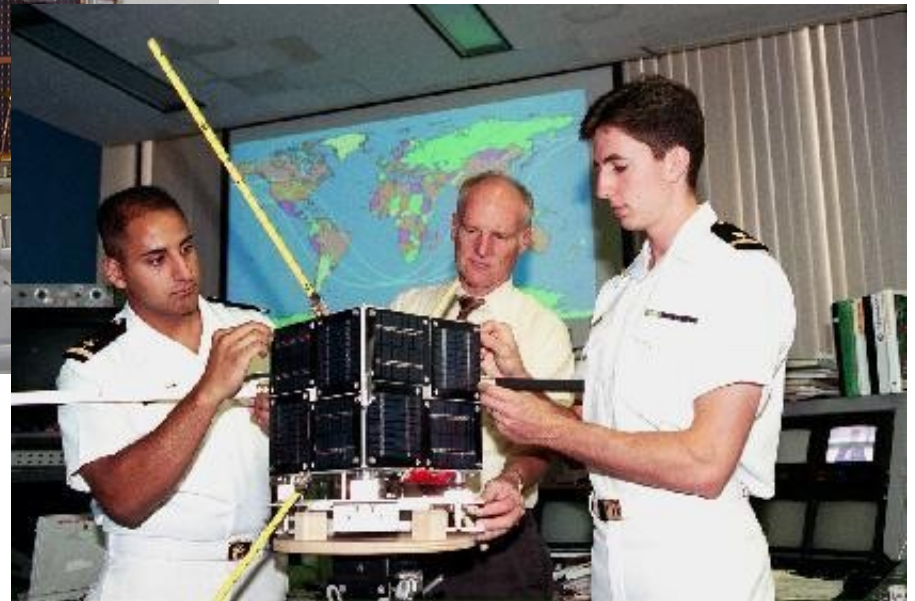
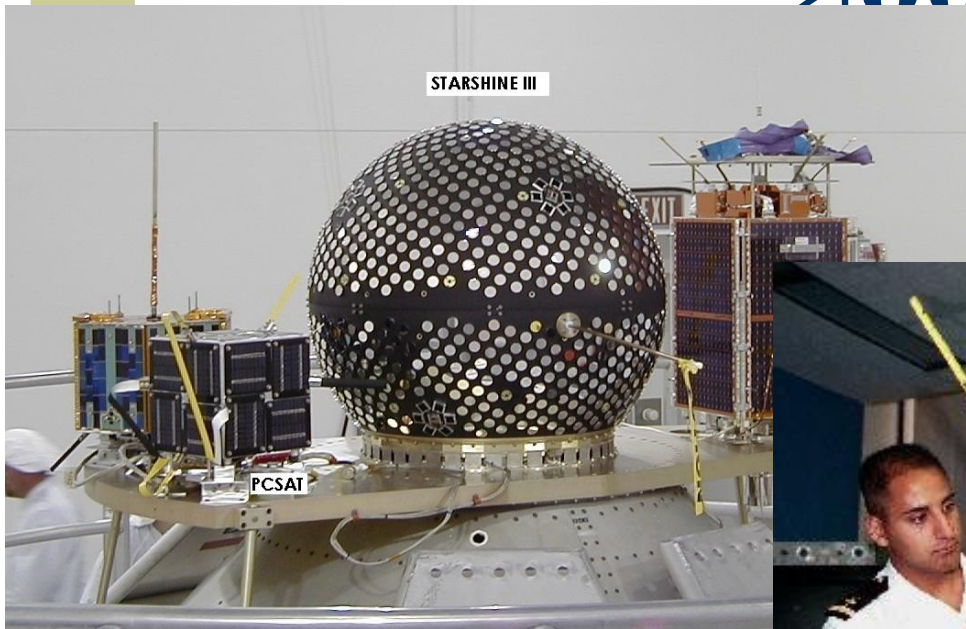
➤ **MARSc**om**** – **Manifest. STS-116**

➤ **ParkinsonSAT** – Commenced Spring 2006

USNA Constellation



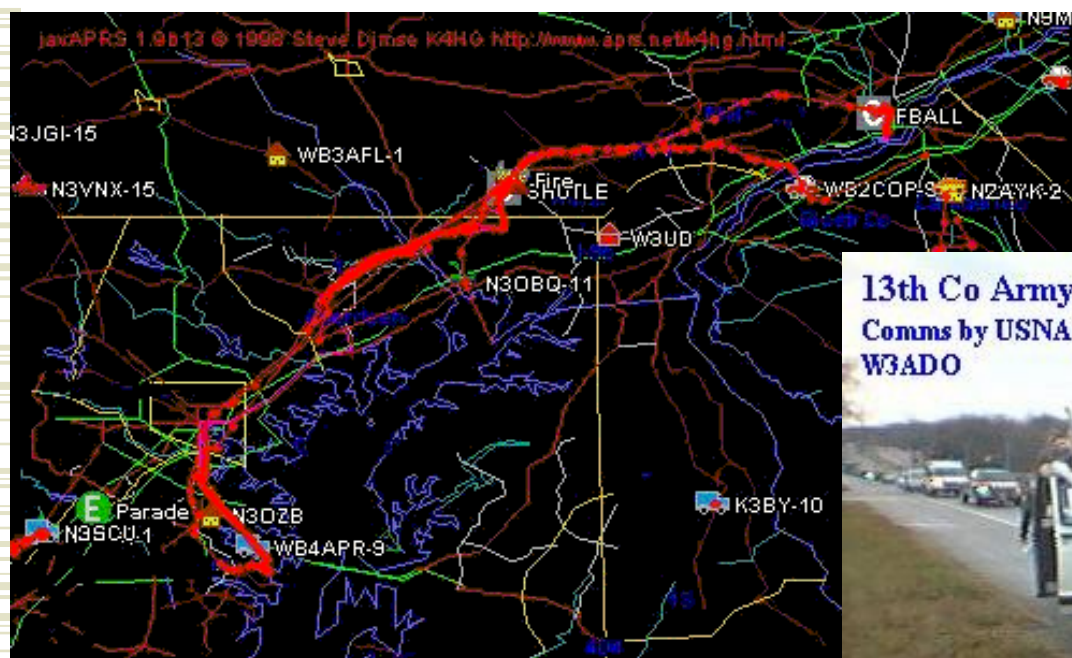
PCsat, launched 30 Sept 2001



Team: 6 Students, 2 Profs, 1 Engineer
Over 2200 mobile Amateur Satellite Users

PCsat Mission

Data Relay (Situational Awareness) for
Mobiles and Handheld radios. GPS



13th Co Army/Navy Football Run
Comms by USNA Radio Club
W3ADO



Typical PCsat User Station



Typical Pass Display

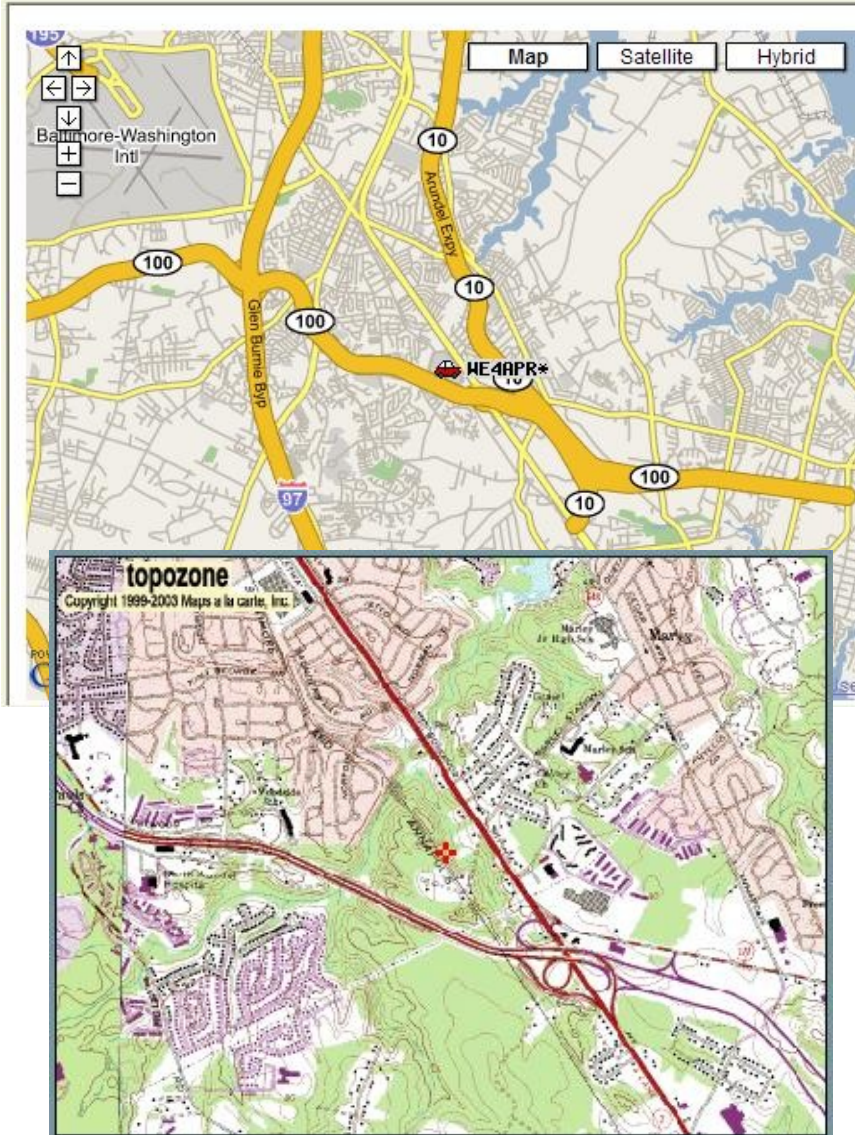


All satellites are shown on the map as moving objects. Across the bottom of the screen the next 2.5 hours of satellite passes are shown in a graphic showing the maximum elevation of the pass.

ISS / PCsat Internet Linked volunteer Groundstations

TCP
IP: WH6SJ
SANA Arctic Station

Internet Linked Data Displays



www.ariss.net
pcsat.aprs.org

PCsat “Student Operations”

PCsat Afloat Operations Test

CDR	Chas Richards	W4HFZ (CO)
LTjg	Brian Young	KC5KLE
ETCS	Curtis Mathews	N1FDW
ENS	Brian Scrabek	PCsat design team

TH-D7

APRS HT

PalmPilot
Satellite
Tracking

USS Parche SSN-683



Other Experiments through PCsat

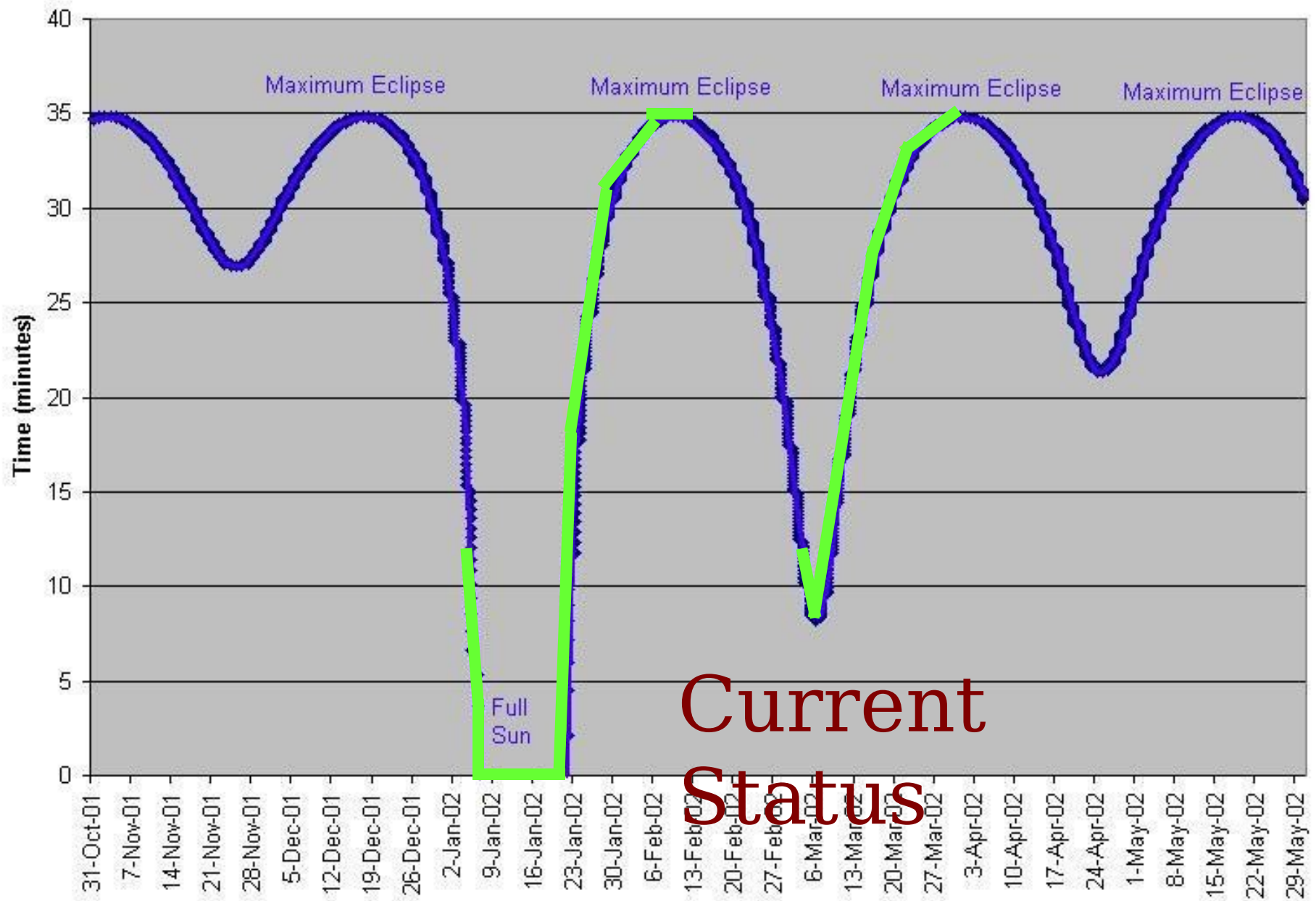


The Flashline Mars Arctic
Research Station (FMARS)
2002 Field Season



- **Antarctic WX station**
- **F-16 downed flyer demo** (Rome Air Development Center)
- **Arctic Tracking** (trucks up frozen rivers >70° Latitude)
- **ISS Joint Ops** (2 weeks of constellation flying)
- **USNA Marconi Re-enactment** (St Johns Newfoundland)

PCsat Eclipse Times in Minutes



Air & Space Museum

**Donated April 2004 to
Smithsonian**



**For
Display
At Dulles**

PCSAT2, DOD synergy in the Amateur Satellite Service

Bob Bruninga

US Naval Academy Satellite Lab

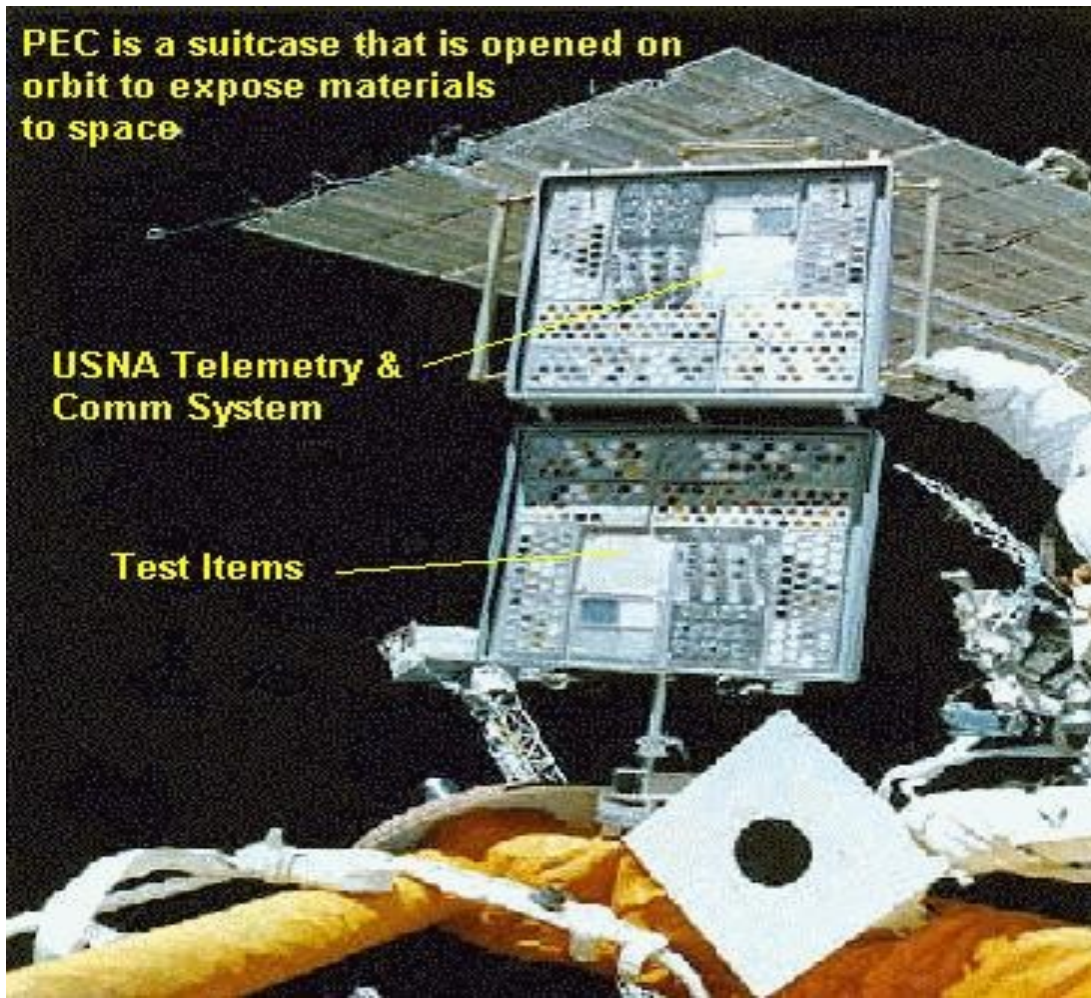
Amateur Satellite Service partnering with DOD and ARISS

- ◆ Very short development time
- ◆ Simplicity and off the shelf
- ◆ Educational Project
- ◆ Usable communications service to Users
- ◆ Telemetry for Space Environment
- ◆ Configuration controlled on the ground



DOD MISSE5 Opportunity

Passive Experiment Container - PEC

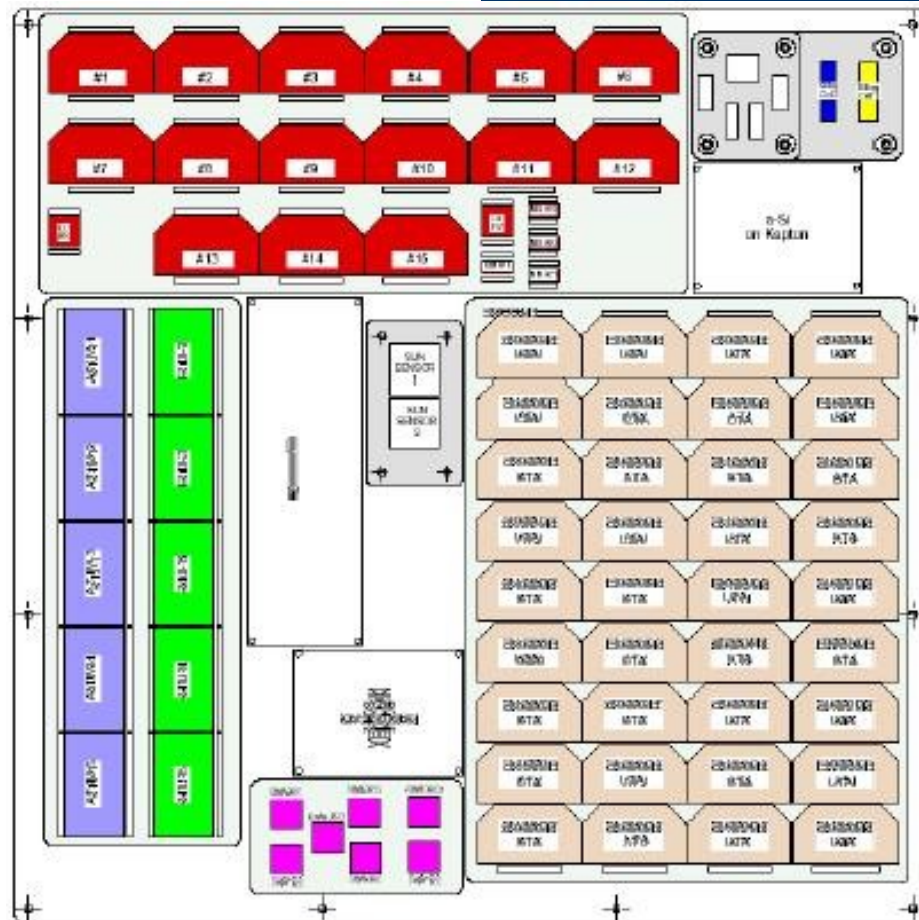


25" square by 6" thick Suitcase

Opens to expose samples to space

We got back

NASA/Glen Solar Experiment



40 Solar Cell Samples

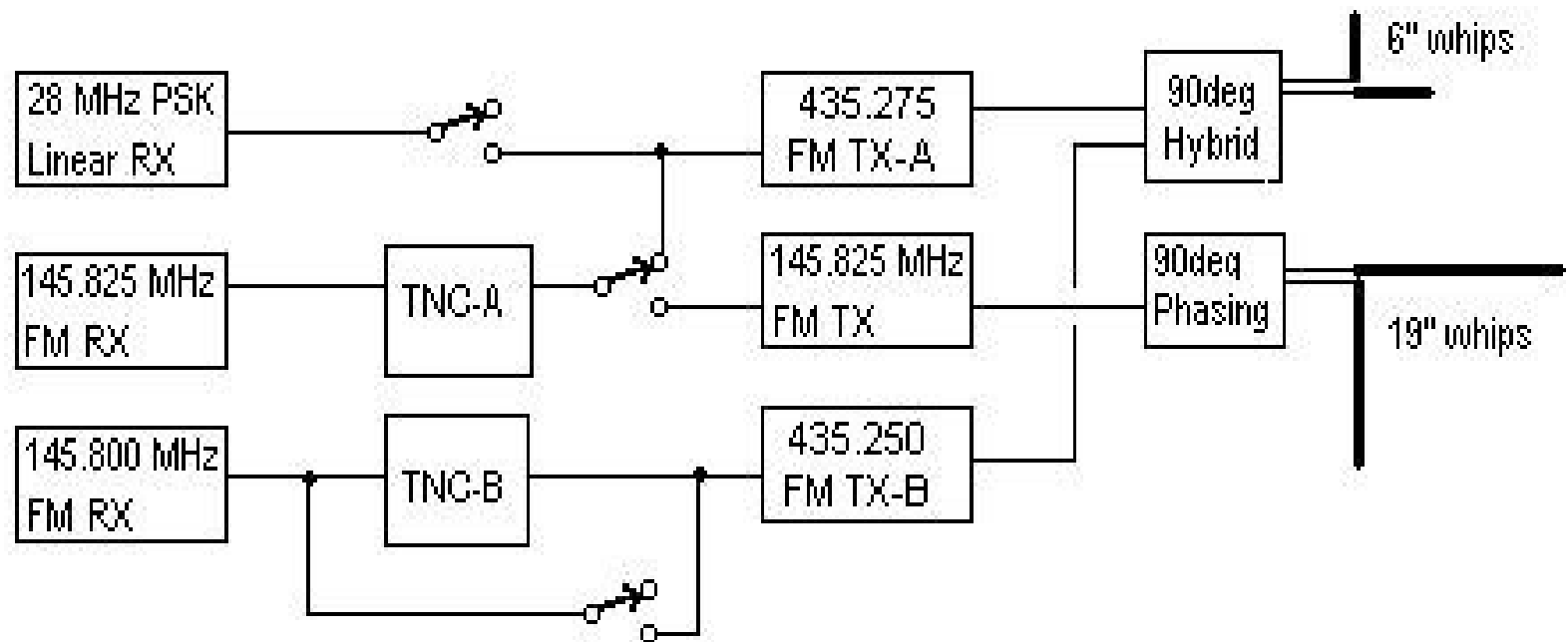
Latest triple junction technology

The PCSAT2 Student Team



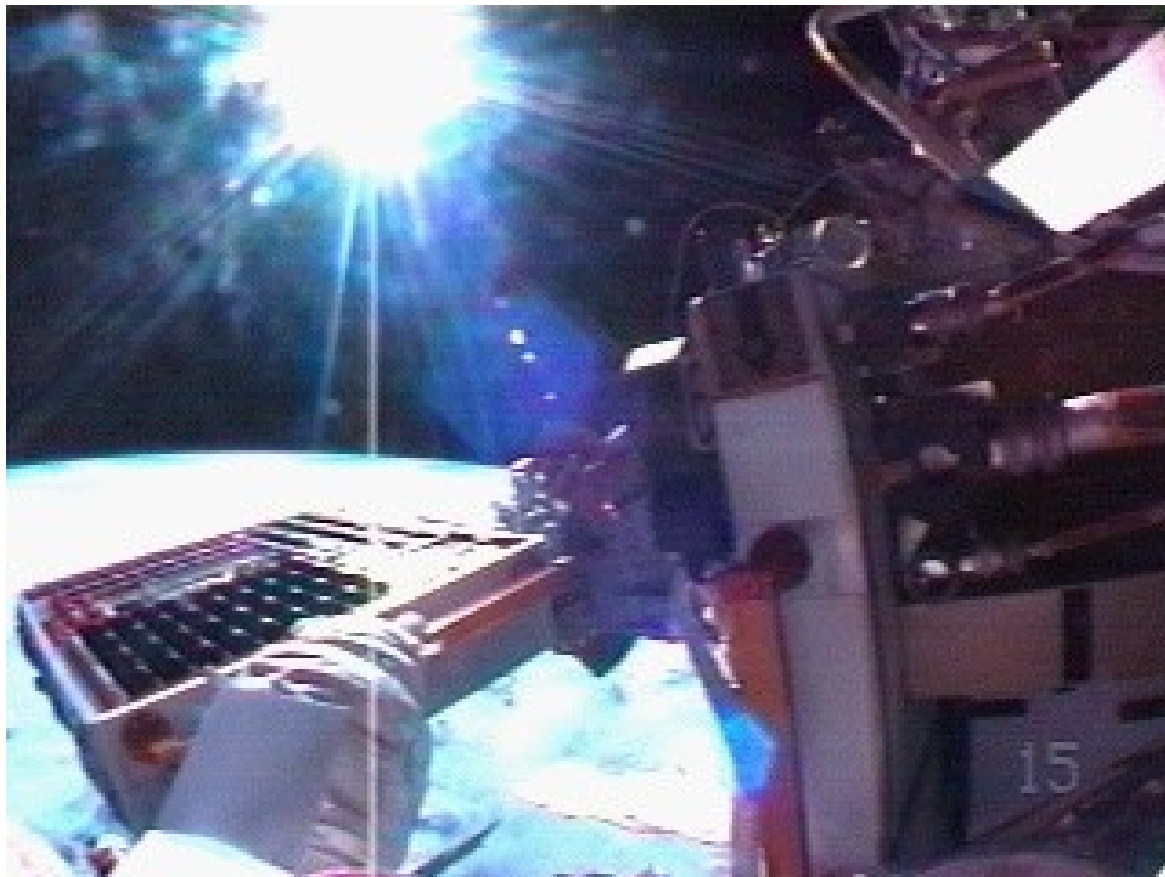
Satellite Transponders

PCsat2 COMMS FUNCTIONAL BLOCK DIAGRAM



PCSAT2 on ISS

**Launch 26 July 2005! EVA-installed 8
days later.**



PCSAT2 Location

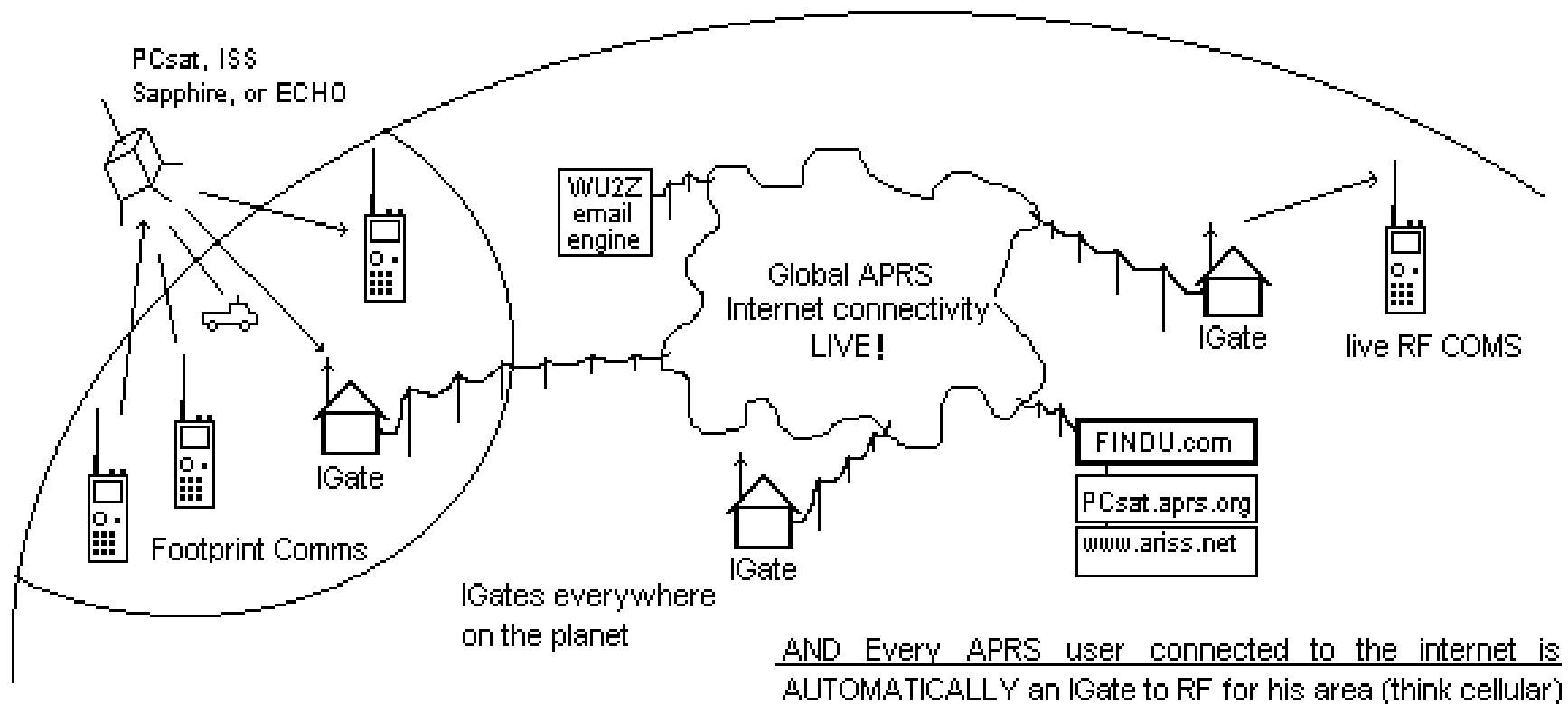
Launch 15 May 2005!

EVA-install 8



Global Situational Awareness Network

Global APRS Real-Time Connectivity (End-to-End Everywhere)



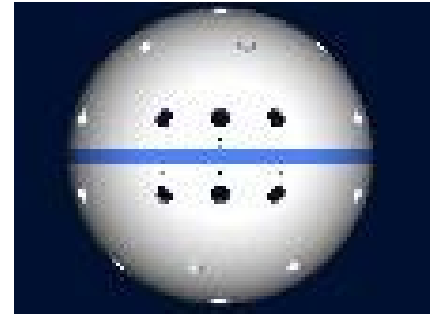
Typical User Station



Encourage Schools and Students to get involved in Space

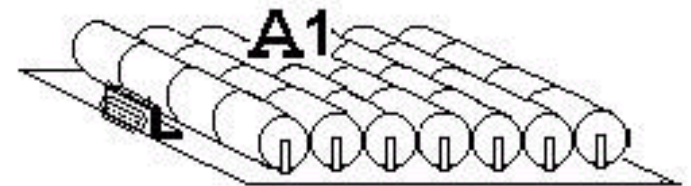
ANDE Satellite

Joint Project with
NRL

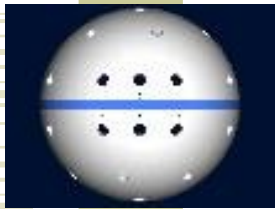


Midn Patterson making SWR measurements outside in full sky.

Atmospheric
Drag
USNA Comms
Telemetry
- Temperature
- Attitude
- Laser
Control



Primary Lithium
Batteries

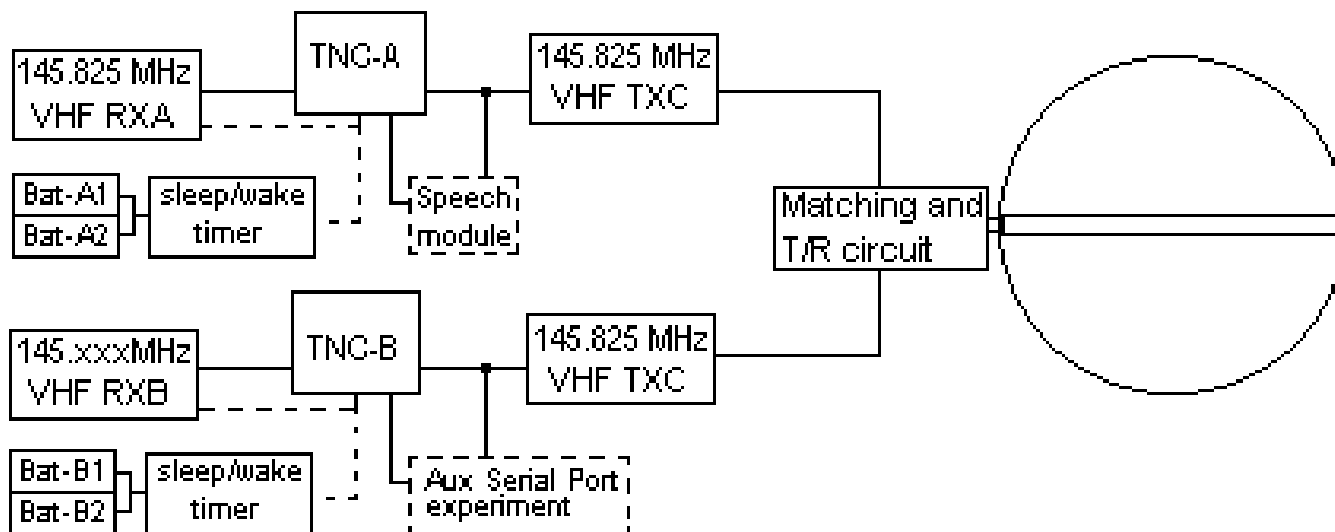


ANDE Satellite

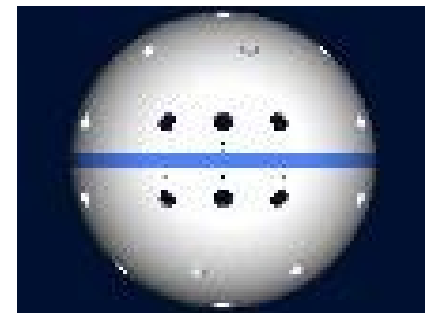


ANDE COMMS Block Diagram

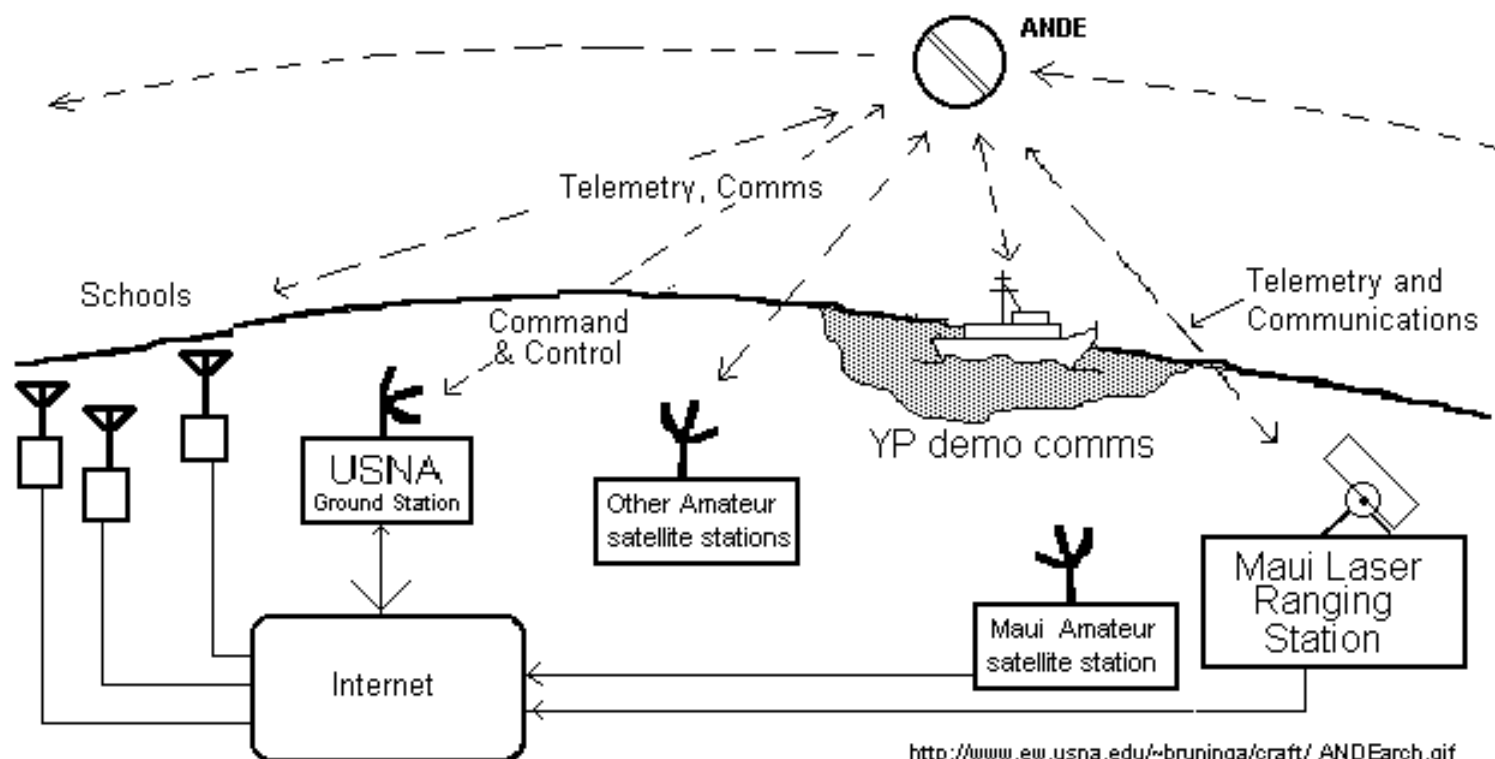
WB4APR



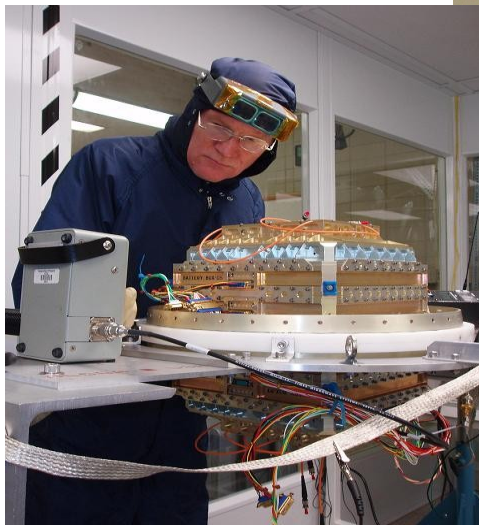
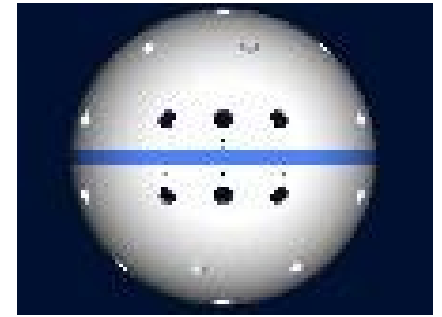
ANDE Satellite



ANDE System Architecture



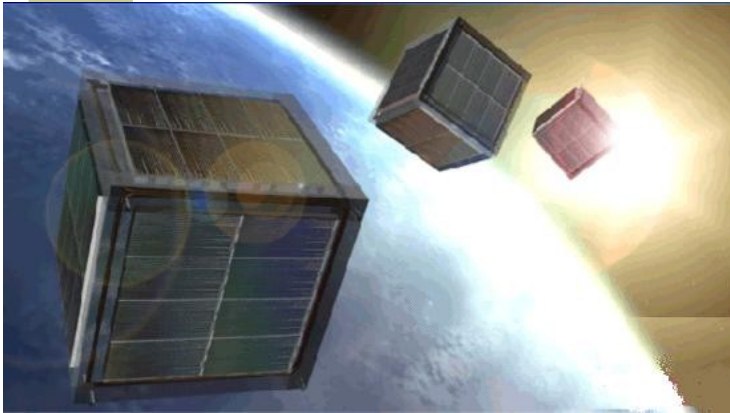
ANDE Satellite



Awaiting
Launch STS-
116 Dec 06

Stanford Cubesat Projects

50 in
construction!



AIAA/US
U
Conferen
ce

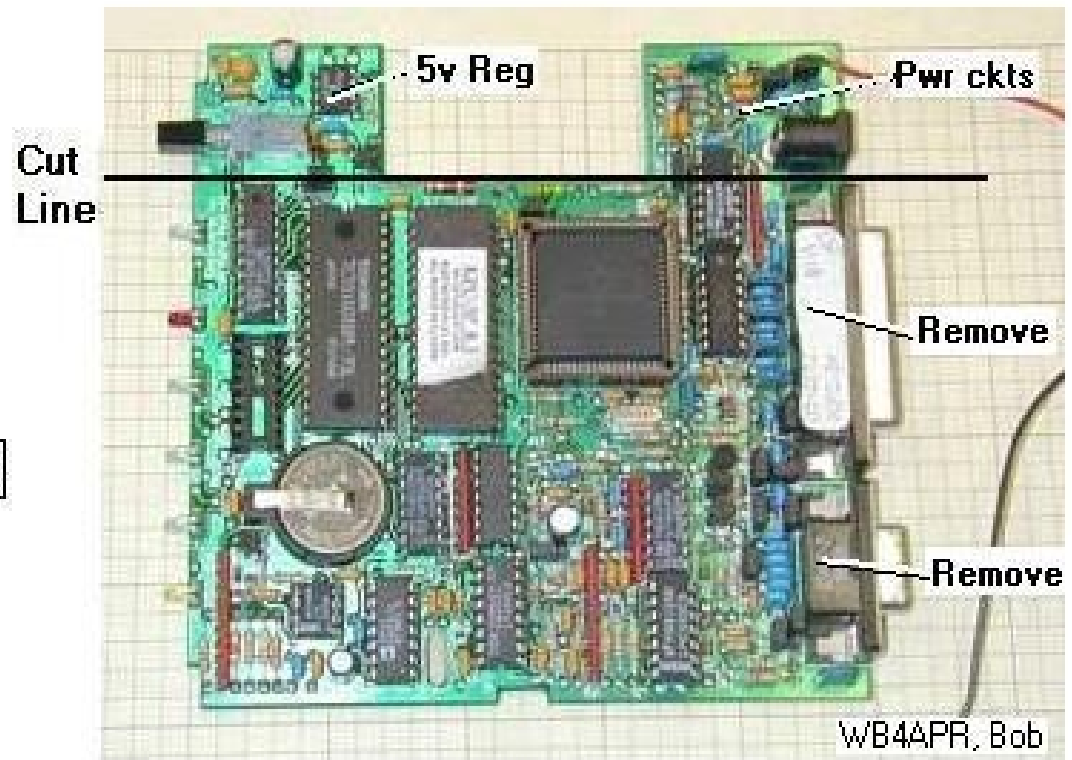
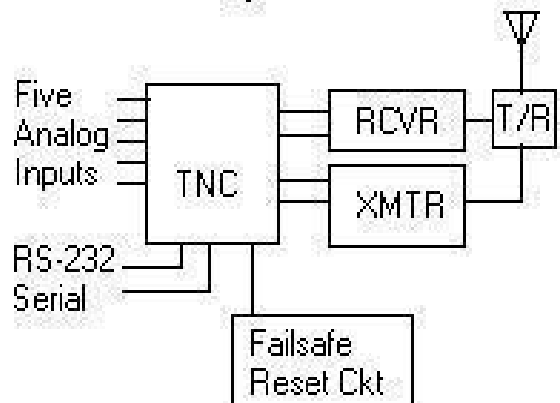
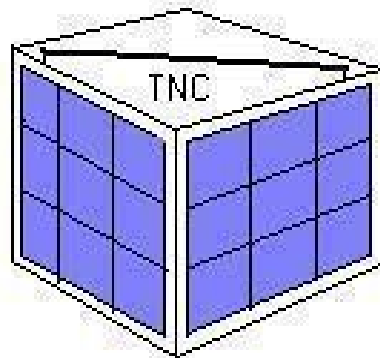
30% of all
papers
were
related to
CUBESAT
S



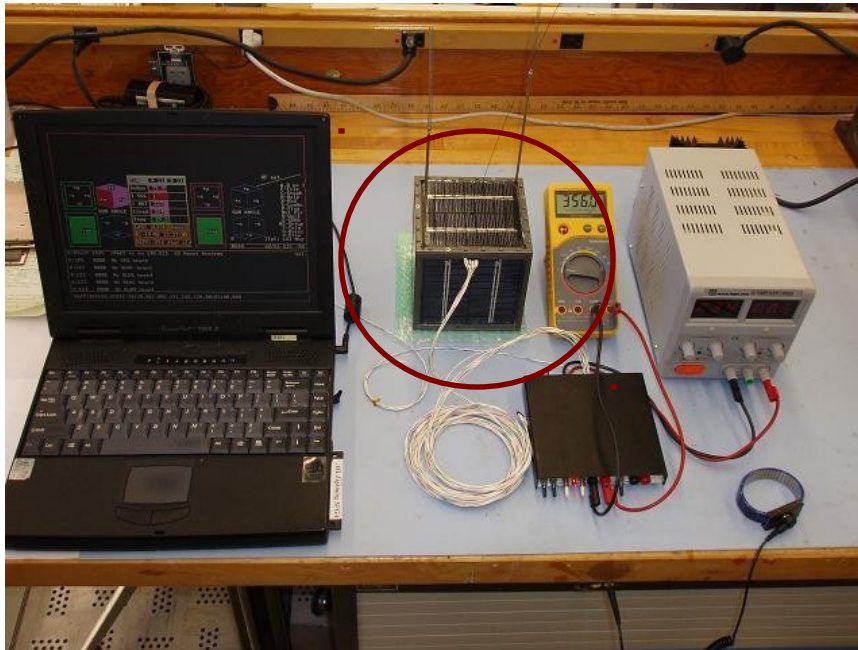
Simple LABsat TLM/CMD System

(proposed)

Naval Academy_A Cubesat with KPC-3+ Digipeater/Telemetry



RAFT Project (two Satellites)

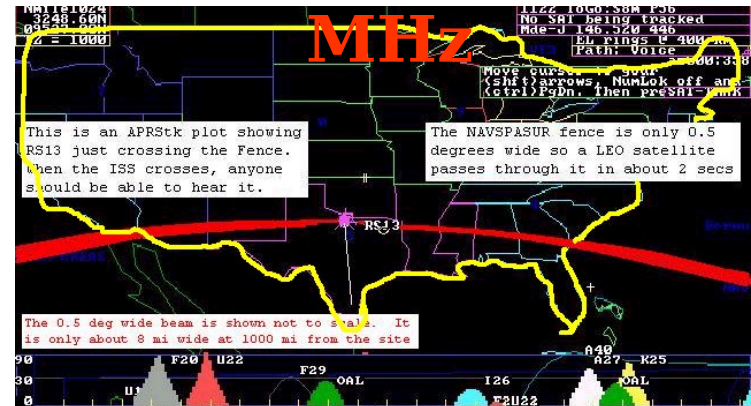


RAFT-1
(~PCsat)

MARScom

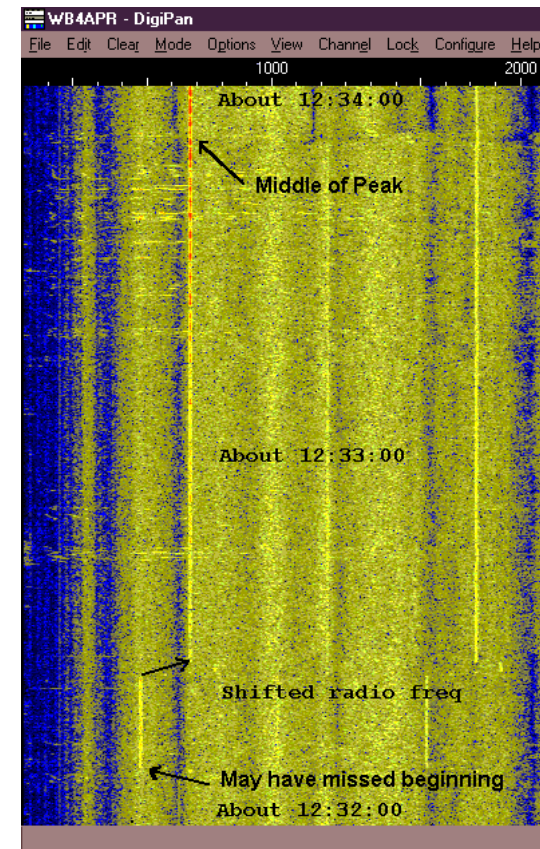
216.98

MHz



**NSSS Radar
Fence**

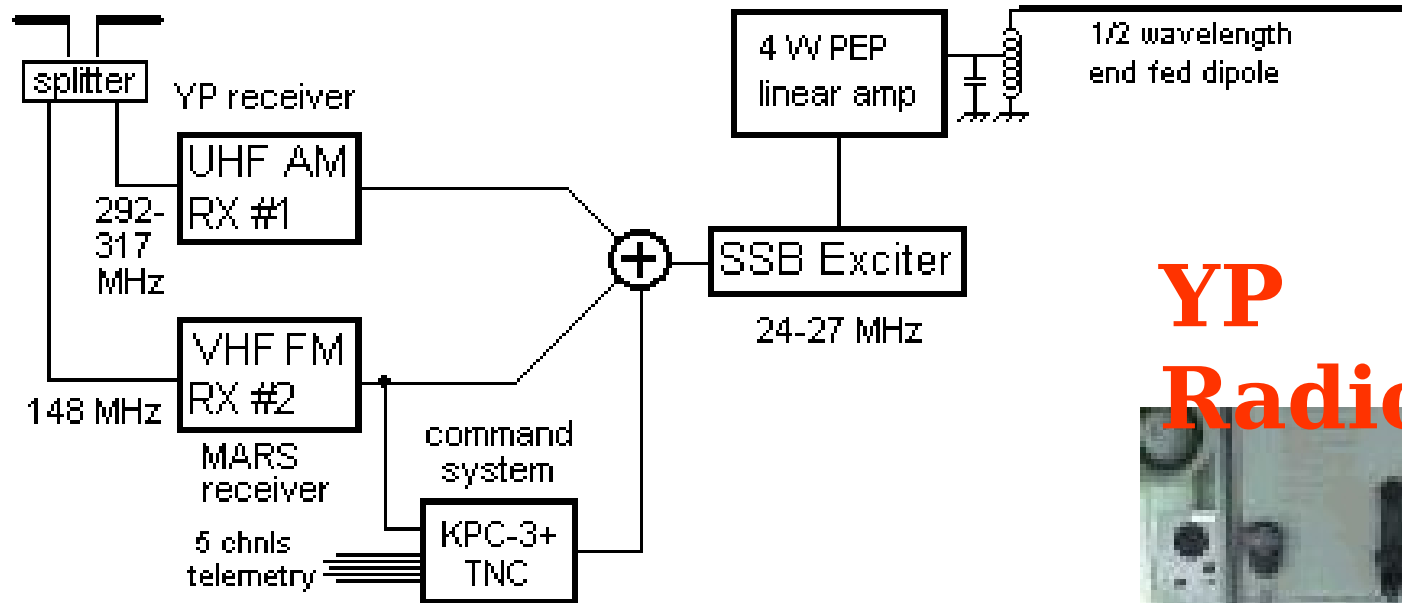
NAVSPASUR Radar Fence



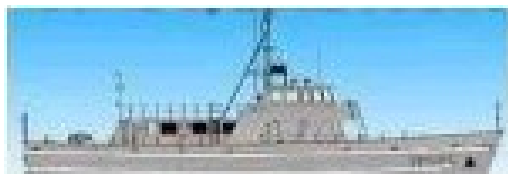


MARScom Voice Transponder

VHF/UHF dipole



**YP
Radios**



UHF AM up

**HF SSB
downlink**



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➤ Satellite and
communications Labs

➤ Satellite Design Projects

➤ Ground Station Ops

➤ Extracurricular

PCSAT-1, PCSAT2

12 Meter (AO-40)

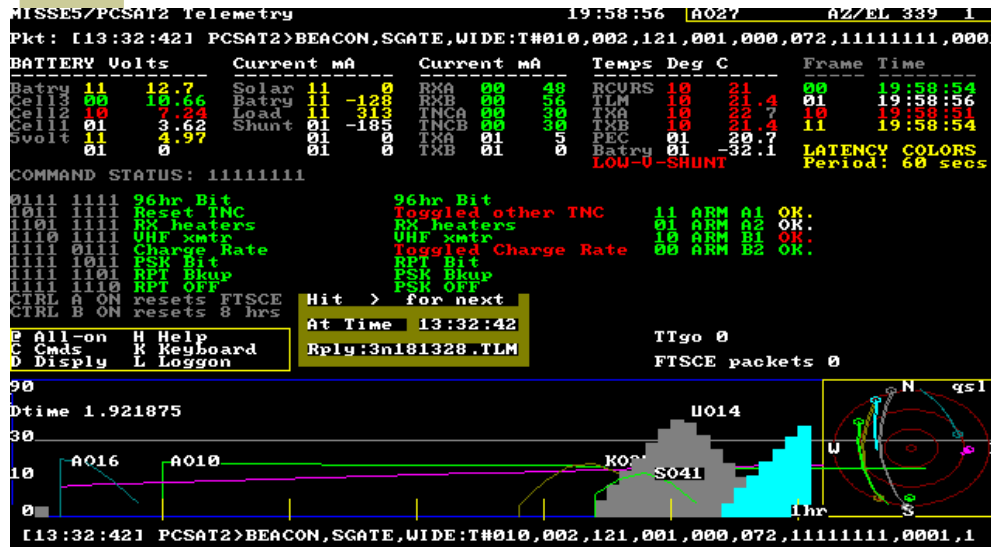
C/Ku TVRO (NASA
TV)

Teleconferencing

Summer Seminars,
Tours

AMSAT Tracking

PCSAT1/2 Telemetry & Commandin



It takes 4 packets for a complete telemetry set. White shows the most recent values, Green is 10 seconds old, yellow is 20 seconds old and red is 30 seconds old. This is at the highest rate. Normally PCSAT2 will 40 seconds for all 4 sets. The upper right FRAME and TIME show the time of each frame

The middle area of the screen shows the ON/OFF status of the command bits.

The bottom shows the elevation of the next 60 minutes of satellite passes. Solid color in

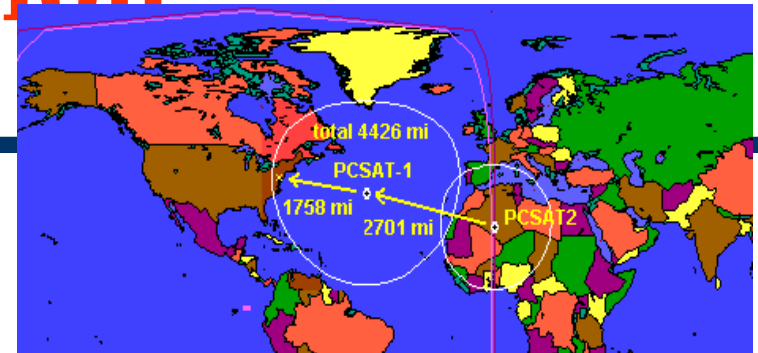


Telemetry screen of PCsat during periods of maximum eclipse cycles (35 mins eclipse, 65 mins of Sun). This snapshot was taken at 1621z on 21 Oct 2001, 20 minutes or (1/3rd) into the Sun. Notice the still cold temperatures. Also notice the low Battery voltage 14.x volts and high charge currents of 178 and 204 mA. Also the UV String experiment is separated.

USNA Satellite Lab/Ground Station



ISS commander cheers for Army in contact with Naval Academy's W3ADO (Dec 1, 2005)
 During a brief contact November 26 between the US Naval Academy's W3ADO and NA1SS, ISS Commander Bill McArthur cheered for an Army win "Thanks very much for the contact, but I can't resist," said McArthur, a US Army officer and veteran. "Go, Army. Beat Navy!"



03/19/2006 17:56:53.00 UTC < 3. PCSAT2 >
 Azimuth Elevation Range (km) Doppler Off
 USNA 77.954° -30.568° 7142.495
 Lat: 23.697°N Lon: 1.006°E Alt: 349.423 Rev: 41906
 472.2 km WNW of Tamanrasset, Algeria

During the March 2006 joint PC1<=>PC2 operations period, numerous dual hop telemetry and user packets were observed. This telemetry packet from PCSAT2 is just about as far as we can get with satellite-to-satellite-to-USNA. Notice how few European or USA users were in the footprint making it more probable that PCSAT-1 could hear PCSAT2's signal. WB4APR

RS0ISS>PP0PP0,SGATE,qAo: Go Army beat Navy!

PCSAT-1>APRS,SGATE,qAo: Go Navy Beat Army!

Alternating ISS Pass Geometries for US Naval Academy at 39°N latitude
PCSAT2>APRS,SGATE,qAo: Go Navy Beat Army!



Two excellent overhead passes per day (2,6)
 Four OK passes up to 10 deg (1,3,5,7). This pattern occurs every other day.



Four good 30 degree passes per day (2,3,6,7).
 Four very low <5 deg passes per day (1,4,5,8).
 Pattern occurs every other day. WB4APR

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Other Activities



**Space Day
(Air&Space)**

**AMSAT (North
America)**

**Marconi 100th (St
Johns)**

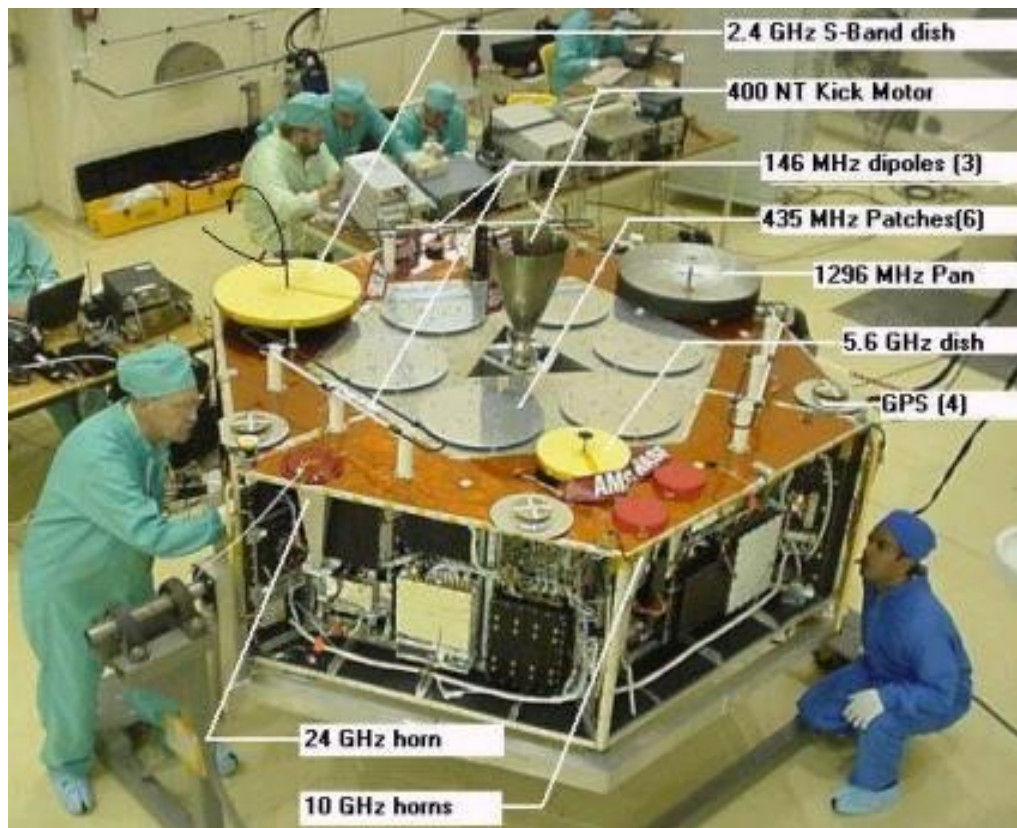
BSA RadioBadge

School Mentoring

Balloon Tracking

AMSAT Operations

AO-40 Rescue



Satellite Tracking:

- UO-14, UO22
- FO-20, FO-29
- NO-44, NO-45
- PCSAT2

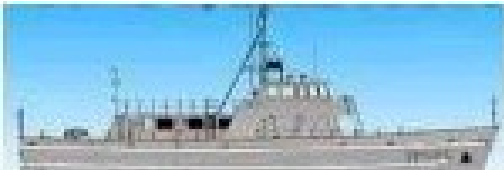
USNA Extracurricular Activities

W3ADO, oldest USNA ECA
(1928)

Annual Moonbounce Event



Football & Boat GPS Tracking, Comms,



Internet
Sea
Trials

